

Analysis on Complexity and Evolution of E-Commerce Ecosystem

Honglu Liu¹, Zhihong Tian^{2*} and Xiaolan Guan³

¹Beijing Jiaotong University

^{*2}Beijing Jiaotong University

³Beijing Institute of Graphic Communication

liuhonglu@jtys.bjtu.edu.cn, 10113130@bjtu.edu.cn, 08113101@bjtu.edu.cn

**Corresponding Author*

Abstract

In this paper, we analyze the complexity of e-commerce ecosystem. The concept of e-commerce ecosystem is application the theory and research of natural ecosystem, business ecosystem and complexity science in the field of electronic commerce and those concepts provide system science methods and ecology methods to e-commerce ecosystem research. A population conceptual framework which is based on ecosystem and complexity network is proposed. Then, the complexity is examined from two aspects—the systematic and ecological ones. Finally, evolution process of e-commerce ecosystem is explained by a graph.

Keywords: *e-commerce ecosystem, business ecosystem, conceptual framework, complexity science*

1. Introduction

E-commerce roots in the information society and has enormous potential capacity of development. It impacts on national economy and our daily life. The research of e-commerce does not only have significance in academic, but also has practical significance in national policy-making and business strategy. The concept of e-commerce ecosystem provides a new perspective to e-commerce research. However, most literatures focus on the superficial statement when referring to e-commerce ecosystem, lacking deep approach from complexity.

The goal of complexity science is to understand these complex systems—what “rules” govern their behavior, how they adapt to change, learn efficiently, and optimize their own behavior. Complexity is based on systems theory but enriches the analysis with new concepts. The key is the interconnectedness of the actors, or agents, and phenomena that arise from their interaction. Complexity emphasizes interconnectedness of the parts of the system and dynamics that this interconnectedness induces. The aim is to understand, which can be defined as understanding behavior, relationships or patterns.

In this paper, we try to analyze the complexity of e-commerce ecosystem. First, the origin of e-commerce ecosystem is discussed. The concept of e-commerce ecosystem is application the theory and research of natural ecosystem, business ecosystem and complexity science in the field of electronic commerce and those concepts provide system science methods and ecology methods to e-commerce ecosystem research. A population conceptual framework based on ecosystem and complexity network is proposed. In this framework, all elements in ecosystem can be divided into several populations, and there are kinds of relationships among them. Then, the complexity is examined from two aspects—the systematic and ecological ones. Finally, evolution process of e-commerce ecosystem is explained by a graph. The role

of diversification in the process is discussed.

2. E-Commerce Ecosystem

2.1. Origins of e-commerce Ecosystem

The e-commerce ecosystem is application the theory and research of natural ecosystem and business ecosystem in the field of electronic commerce. Business ecosystem draws analogies from nature and studies how these phenomena may be observed in business context. In the year of 1986, James Moore (1993) first proposed the concept of business ecosystems, which began the study of metaphorical analogy between ecosystems and business systems. After several decades, concepts “industry ecosystems”, “corporate life cycle theory”, and “corporate niche theory” and so on, are proposed (Moore, 1996). There are ecological communities in nature in which species exist as part of a rich network of connections. These communities form local ecosystems which have system level properties. The process of co-evolution is producing even more complex economic webs in the world of high technology, with software, hardware, and Internet companies interacting to produce a complex economic web.

The concept of e-commerce ecosystem is derived from business ecosystem. It is an inevitable form when business ecosystem develops to an advanced stage. Traditional business model — “competition-cooperation” which is between enterprises, has reached an unprecedented depth and breadth in e-commerce environment, and any businesses and relevant participants (suppliers, producers, distribution, consumers, competitors, risk bearers, and other related industries and businesses, government agencies, industry and social organizations, *etc.*), cannot be separated from this system. We know that business (including e-commerce) is a “system” above all, and in line with the definition of “system”. The fundamental reason for leading the concept “ecosystem” into the research is that the “elements” in “system” and system itself are “live” and “interact through material cycling and energy flow”.

It should be pointed out that there are differences between natural and business ecosystems. First of all, in business ecosystems the actors are intelligent and are capable of planning and picturing the future with some accuracy. Second, business ecosystems compete over possible members. This kind of behavior can not be observed in nature. Third, business ecosystems are aiming at delivering innovations, where natural ecosystems are aiming at pure survival.

Ecosystem is a “system”, and the development of system science provides important methodology to define and study content and features of e-commerce ecosystem. Complexity sciences which emerged in the 1980s, is a new development stage of systems science. It does not only lead to changes in natural science, but also increasingly penetrate into philosophy, humanities and social sciences. The primary contribution of complexity science is that it defines e-commerce ecosystem as a “complex system”.

Figure 1 illustrates how the concept e-commerce ecosystem originates, and explains the relationships with other concepts and theories. From the graph we can see that, e-commerce ecosystem originates from system, ecosystem and business ecosystem, and those concepts provide system science methods and ecology methods to e-commerce ecosystem research.

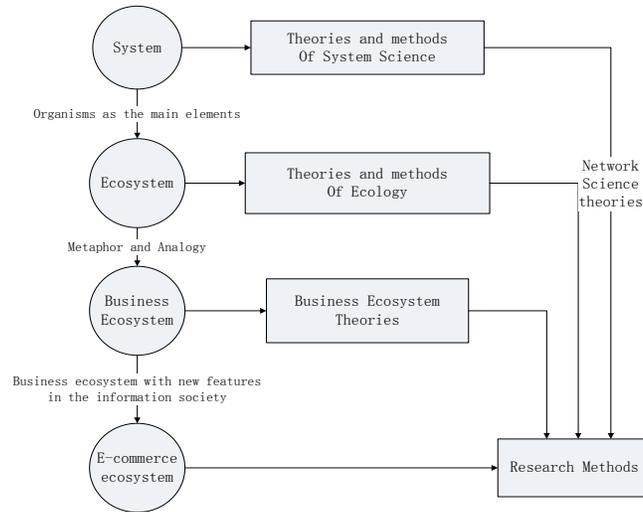


Figure 1. The Origin of e-commerce Ecosystem

2.2. Population Conceptual Framework

The theory of business ecosystem has broken the concept—“single win” in traditional enterprise competition. The theory emphasizes that the business environment is a closely linked and mutually dependent symbiotic system, and enterprises need to work with others for development in environment. The theory of business ecosystem beyond the scope of general industry, using dynamic idea of development, describes relationships between business and environment. In our country, obvious symbiotic relationships and clustering phenomenon have appeared, and the organizational elements, structure, and function of e-commerce ecosystem have shown significant ecological features. Therefore, it is probably easier to make an analogy between the concept of ecosystem and e-commerce system, according to the research results of the business ecosystem. The e-commerce ecosystem is logically divided into three levels—individuals, populations, and communities. Homogeneous individuals compose the population, and different individuals compose community. The members of population can be divided into four kinds—leadership population, key population, support population and parasitic population.

Leadership population (core population)

Core population is in the core e-commerce business, who is the leader of the entire ecosystem resources. They integrate and coordinate the resources of ecosystem by providing a platform as well as regulatory services. Take Alibaba Group as an example, it has attracted a huge number of buyers, sellers and a large number of relevant institutions involved in the retail platform— Tmall. An e-commerce ecosystem is gradually formed. In the ecosystem, Alibaba is a leadership population, parties to the transaction are the key population, and the network transactions ISP and value-added service providers are support population. They share values with other members in the system by making rules and mechanisms, building the exchange community, organizing activities, and establishing strategic partnership of logistics companies.

Key Population

Key populations are the subjects of e-commerce transactions, including consumers,

retailers, manufacturers, professional suppliers, who are consumers of other populations. Competition and symbiosis are primary relationships within populations. There is extensive competition among sellers, and there are symbiotic relationships between buyers and sellers.

Support Population

Support populations include logistics companies, financial institutions, telecom service providers and related government agencies. These populations are not dependent on e-commerce ecosystem to survive, but they can get from the optimized e-commerce ecosystem far more than the profits obtaining from their own competitive advantage.

Parasitic Population

Parasitic populations are value-added service providers serving for the network transaction, including Internet marketing service providers, technology outsourcing providers, e-commerce consulting services providers and so on. These species are parasites on e-commerce ecosystem. Abiotic environment mainly consists of three parts: e-commerce information resources, e-commerce infrastructure, and social environment.

The creation and growth of the core e-commerce businesses cultivate a new market environment, which can accommodate more species to participate in. Endogenous development forces of e-commerce, such as the need for self-reproduction and evolution of each species, encourage more subjects into the ecosystem. Supporting factors of e-commerce development, such as electronic payment, logistics, favorable policies, accelerate the breeding of the system and expand the range of the ecosystem. The development of the ecosystem attracts a large number of value-added service providers as parasitic, and improves the survival environment of e-commerce. The endogenous and exogenous reasons enrich species of e-commerce, form more perfect circulation, and ultimately achieve the eco-building and ecological symbiosis of members of the e-commerce ecosystem. On this basis, value creation, value sharing and co-evolution are achieved. Conceptual framework of e-commerce ecosystem is as Figure 2.

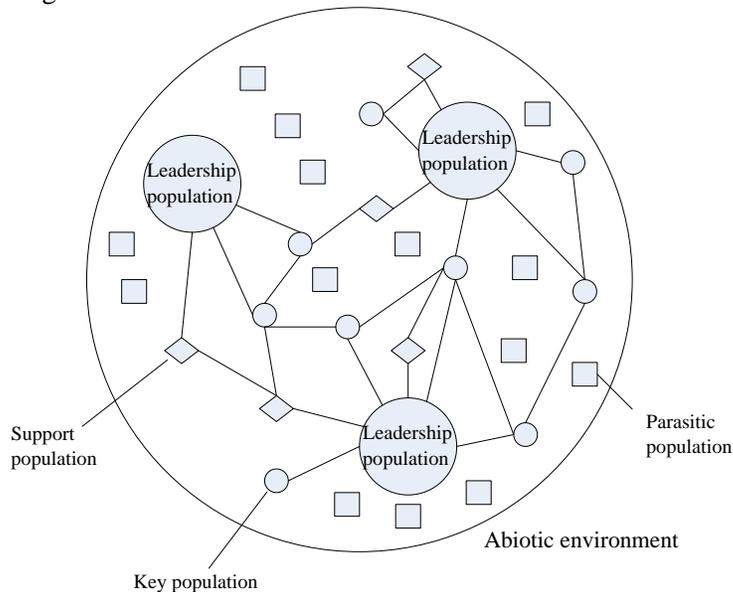


Figure 2. Conceptual Framework of e-commerce Ecosystem

We can assume that e-commerce ecosystem is a complex ecosystem. It is a complex system, and has the characteristics of ecosystem. Here we explore the complexity from two aspects— systematic and ecological ones.

3. Complexity of E-Commerce Ecosystem

3.1. Systematic Complexity of e-commerce Ecosystem

The exact meaning of system differs due to different usage, different subject and different methods, but the general concept of universal system can be defined as follows: “A system is a set of elements (often called ‘components’ instead) and relationships which are different from relationships of the set or its elements to other elements or sets”. Systematic complexity of e-commerce ecosystem includes variation, integrity, hierarchy, and self-organization.

Variation

The system is composed by several different kinds of elements (parts). In e-commerce systems, the “narrow sense elements” are directly involved in e-commerce activities, such as producers, distribution, consumer, platform providers, regulatory agencies, *etc.*; the “generalized elements” also include environment around the system—social, political, economic, and cultural environment. In addition, kinds of elements could be more or less with the development of ecosystem.

Integrity

The integrity of the system is based on organic nature of internal and external links. E-commerce ecosystem has features of system integrity, including three layers of meaning. First, it has an overall structure which only belongs to e-commerce ecosystem, and it has the feature of irreducibility. Second, the organic nature of e-commerce ecosystem is achieved by the flow of matter, energy, and information through components of the ecosystem. Third, the function of e-commerce ecosystem reflects the integrity of system.

Hierarchy

System structure has hierarchy. Any system is always included in a larger system, and become a subsystem or element of the system. E-commerce ecosystem also has hierarchy. First, e-commerce ecosystem is a subsystem of a higher level system, that is, above all, a subsystem of the social system. Secondly, e-commerce ecosystem itself is a complex system with multiple layers of subsystems. For example, e-commerce ecosystem contains various industries and enterprise subsystems, consumer subsystems, environment subsystems. Business alliances can be established among enterprises; upstream and downstream enterprises can form an ecological chain; enterprises that have the same natures can constitute the industry population. Interaction of each regional ecosystem in their environment forms a complete e-commerce ecosystem.

Self-organization

In an organization population context, self-organization implies the absence of central or outside controller. The system has been given the freedom to organize according to its own needs and capabilities. Basically, a self-organizing organization population develops through decentralized decision making. It is enabled by market economy system. In any real life organization population, however, there are different kinds of interventions by the public

sector. These can be seen as inhibiting self-organization or as creating enabling structures for self-organization.

3.2. Ecological Complexity of e-commerce Ecosystem

The elements of e-commerce systems are "live", and the most significant feature is "life cycle phenomenon". First of all, every e-commerce business has to go through birth, development, maturity, and death or rebirth stage. In 1997, Juntao Wang wrote the first e-commerce web pages, and established a software sales website—"software port". E-commerce began to sprout in China. By the end of 2010, the number of e-commerce sites has reached 18 600 in China. This is the general law of the development of commercial enterprises. However, because of the virtual nature and network externalities, the process of birth, development and death of e-commerce is more obvious than traditional enterprises. For example, in 2010, the model of group purchase site began spreading in China. By the end of June, there are more than 400 group purchase sites in China. On average, in each month, there are 100 sites opening. However, according to the report which is released by the China Electronic Commerce Research Center in early 2012[4], the number of group purchase sites decreased to 3909 at the end of 2011 from the peak number 5188 in July 2011. That means that 1968 group purchase sites have shut down or exit for the fierce competition, which accounted for 33.5% of the total number. Ecological complexity of e-commerce ecosystem includes competition, symbiosis, and co-evolution.

Competition between Elements

Competition is a basic relationship between individuals who have contacts with each other. It reflects that the system and element have individuality, and try to keep the individuality. For limited resources, in order to occupy market share and resources, enterprises of the same type (such as products, mode) must compete with rivals. There are three results of competition: First, both sides continuously improve their core competitiveness, achieve win-win. Second, both sides consume a lot of resources in competition, and result in lose-lose. Third, competitive enterprises defeat the backward enterprises, and become market leader in the field.

Symbiosis of Elements

Symbiosis is a long-term interaction among different biological species. The definition of symbiosis is controversial among scientists. Some believe symbiosis should only refer to persistent mutualisms, while others believe it should apply to any types of persistent biological interactions. Some symbiotic relationships are obligate, meaning that both symbionts entirely depend on each other for survival. Others are facultative, meaning that they can, but do not have to live with the other organism.

The concept of business ecosystem is derived from the reflection of excessive competition between enterprises. The representative of the theory—James Moore (1993) points out that the business ecosystem is an economic union composed by individuals, organizations and subsystems, and based on the interaction between organizations and individuals. Organizations and individuals are organisms in business ecosystem. The individuals refer to consumers, the organizations refer to various types of enterprises, and the subsystems refer to strategic alliances among enterprises. Marco Iansiti and Ray Levien (2004) believe that as same as species in natural ecosystems, every company in the business ecosystem has a common destiny with the entire business ecosystem. The business environment is a close-knit, mutually dependent symbiotic system. In e-commerce ecosystem, sub-ecosystems (or

communities) with a core business have symbiosis, such as Alibaba, Intel ecosystem, and Apple ecosystem.

Co-evolution of the System

James Moore believes that co-evolution is a more important concept than competition or cooperation. The design, production or distribution processes of a product involve many participants, and a pattern of common destiny forms.

In an organization population context co-evolution arises from the interconnectedness of these organizations. Connections can be monetary and product flows, but the role of knowledge in the formation of connections is the most important. Because of interconnectedness the organizations have an effect on each other. The decisions that an organization makes can enable or force other organizations to make some other decisions, and vice versa. Co-evolution can be interpreted as competitive, mutuality or exploitative based on the nature of the relationship that the co-evolving organizations have. However, the trigger of co-evolution is always knowledge.

In e-commerce ecosystem, all species can be classified as producers, consumers and decomposers. Producers convert products and services into profits. Consumers cultivate the producers' ability to provide follow-up products. The decomposers play the role of handling of producers' and consumers' waste, and maintaining development of the ecosystem.

4. Evolution of E-Commerce Ecosystem

The system state of "dynamic system" changes over time and the output is not only related with the input in the same time, but also related with the input any previous time. Such as a variety of specific biological systems, social systems, they show state changes, the process stages or life-cycle over time. Similar to business ecosystem, the states of e-commerce ecosystem change over time, and show life-cycle.

From 1997 to present, Chinese e-commerce has experienced three waves: in the first wave (1997-2003), e-commerce market experienced learning, growth and bubble phase; in the second wave (2003-2009), e-commerce market experienced restoration, popularization and crisis phase; in the third wave (from 2009 to now), applications of e-commerce have achieved lots of substantial progresses, and e-commerce is playing a very important role in national economy. So, obviously we can see, e-commerce ecosystem is a dynamic system. The development of e-commerce in China is as Figure 3.

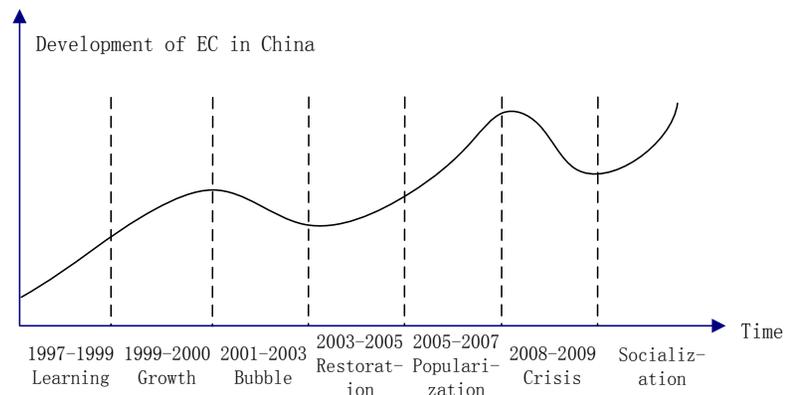


Figure 3. The Diagram is the Development of e-commerce in China

Scholars carried out a detailed comparative study on the evolution process of system from simple to complex, such as biological system, economic system, and social system, which are typical complex systems. They generalize some common characteristics and preliminary qualitative model. We analyze and study the evolution process of e-commerce ecosystem.

In a relatively simple system, the subjects are often homogeneous which means that their structure and function are same. However, in the changing environment, the differences will appear in various forms. The diversity of the e-commerce ecosystem may be defined internally and externally. The internal diversity of commerce ecosystem is revealed in supplier diversity, market diversity, product or service diversity and human resources diversity, the four of which are not separated absolutely but have a lot of intersections. Contrary to the internal diversity, the external diversity refers to the diversities contained by the entire ecosystem in the environment where it exists, which usually determine its position in the environment. The external diversity is actually relative to an enterprise. From the perspective of enterprise, as a component of the ecosystem, the external diversity refers to the diversity of the environment where it exists, which is created by the other organizations in the ecosystem except itself. The external diversity mainly involves communication, competition, cooperation and adaptation. For pursuit of higher efficiency, subjects will tend to division of labor. Thus, the differences are expanded and fixed, which leads to a functional specialization of subjects, and subjects are changed from homogeneous to diversification. Today's information technology leads to a large division of labor in human society, and this development has greatly improved the production efficiency, but also has greatly increased the complexity of the society. The most basic reason of the appearance of e-commerce ecosystem is the intensive division of labor.

Diversification process makes all subjects understand and appreciate the need for cooperation at the same time, and the conflict of benefits distribution is inevitable. The conflict will last for some time to achieve the balance point, which is a process of Game.

Cooperation and competition are the internal dynamic mechanisms of system evolution. The environmental selection is the external mechanisms. Internal and external mechanisms form the basic driving force—self-organization for driving the evolution of system. Specifically, the evolution of e-commerce ecosystem has four stages as Figure 4.

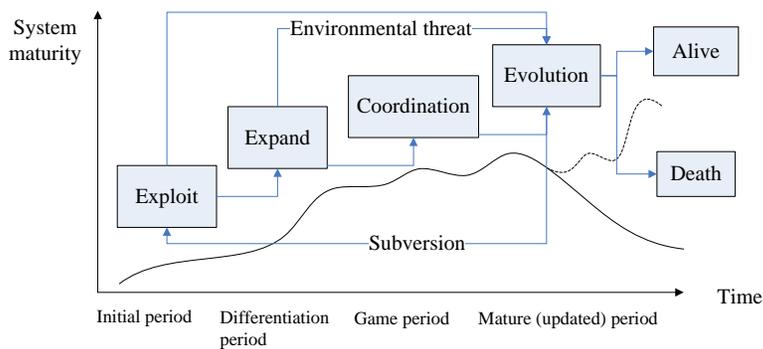


Figure 4. The Evolution of e-commerce Ecosystem

Initial Period (exploit)

Because of uncertainties inside and outside of the simple system, differences among elements begin to appear. This stage is basically running on a relatively simple and low-level system structure. This stage is marked by the emergence of differences. From an ecological perspective, at this stage, the core populations appear, and key populations and support

populations also begin to take shape.

Differentiation Period (expand)

This stage is marked by the differentiation of elements. As the core populations grow, key populations flourish and support populations are strong, and the size of the system is growing. Parasitic populations gradually emerge. The core e-commerce enterprises attract necessary participants by innovative business models or high value-added services.

Game Period (coordination)

The contradictions and conflicts of interests appear, and the process of Game starts. By a specific mechanism, contradictions and conflicts achieve a certain balance. This stage is a crucial stage in which old order is instead by new one. Game process is the main symbol of this stage. The results of emergence should be confirmed in this stage. The interest relationships among various species are more and more complex. In particular, competition and conflict within key species and parasitic species have become increasingly evident. In order to maintain the healthy development of the system, leadership population must adjust and improve system rules.

Mature (updated) period (evolution)

The original elements form new elements by links of cooperation, and lay the foundation for sustainable operation of new system. The main theme of this stage is the establishment of new order and moving toward stability. New elements are in stable. The function and structure become a habit and routine. However, this phase is not long-lasting. When the ecosystem is threatened by new models, policies and regulations, or other external environmental changes, the system will enter an evolutionary stage, and the original models must be changed.

5. Conclusion

According to analysis of systematic and ecological features of e-commerce ecosystem, we can summarize that the system has the characteristics: integrity, hierarchy, open, dynamic, nonlinear, biological, competitive, symbiotic, and collaborative evolution, and so on. Therefore we can conclude that: e-commerce ecosystem can be considered as a complex ecological system. Because of these characteristics of e-commerce ecosystem, complexity sciences theory and ecology theory can be introduced into the study.

In this paper, a population conceptual framework which is based on ecosystem and complexity network is proposed. In this framework, all elements in ecosystem can be divided into several populations, and there are kinds of relationships among them. Then, the complexity is examined from two aspects—the systematic and ecological ones. Finally, evolution process of e-commerce ecosystem is explained by a graph. The role of diversification in the process is discussed. In future, mathematical model and simulation should be studied to analyze mechanisms of e-commerce ecosystem.

Acknowledgement

This work was supported by Beijing Jiaotong University PhD Innovation Research Fund (NO. 2012YJS048).

References

- [1] R. Albert and A. L. Barabasi, "Statistical mechanics of complex networks. Reviews of Modern Physics", vol. 74, no. 1, (2002), pp. 47-97.
- [2] H. Chang and S. W. Chen, "Consumer perception of interface quality, security and loyalty in electronic commerce", Information and Management, vol. 46, no. 7, (2009), pp. 411-417.
- [3] X. Y. Cheng, L. L. Zhu, Q. Zhu and J. Wang, "The Framework of Network Public Opinion Monitoring and Analyzing System Based on Semantic Content Identification", JCIT, vol. 5, no. 10, (2010), pp. 48-55.
- [4] China E-Commerce Research Center. 2011 Survey Report of China E-Commerce Market Data. http://www.100ec.cn/zt/upload_data/down/shjjk.pdf. (2012).
- [5] E. E. Grandon, S. A. Nasco and P. P. Mykytyn Jr., "Comparing theories to explain e-commerce adoption", Journal of Business Research, vol. 64, no. 3, (2011), pp. 292-298.
- [6] M. Iansiti and R. Levien, "The Keystone Advantage: What the New Dynamics of Business Ecosystems Mean for Strategy, Innovation, and Sustainability", Boston: Harvard Business School Press, USA, (2004).
- [7] IRESEARCH. 2011 Top30 of B2C Online Retailers in China. Available at <<http://www.iresearch.com.cn/Report/view.aspx?Newsid=170217>> (2011).
- [8] X. Q. Jing and J. H. Xie, "Group buying: a new mechanism for selling through social interactions", Management Science arch, vol. 57, no. 8, (2011), pp. 1354-1372.
- [9] Z. Katona, P. P. Zubcsek and M. Sarvary, "Network effects and personal influences: the diffusion of an online social network", JMR, vol. 48, no. 3, (2011), pp. 425-443.
- [10] N. Liu, and Y. Chen, "Companies Niche and E-commerce Construction. Soft Science", vol. 5, (2006).
- [11] J. J. Xie, "The Diversity in the E-commerce Ecosystem", Sci-Tech Information Development & Economy, vol. 2, (2009), pp. 127-129.
- [12] J. Moore, "Predators and Prey: A New Ecology of Competition", Harvard Business Review, (1993) May-June, pp. 75-86.
- [13] J. Moore, "The death of competition: Leadership and Strategy in the age of business", Fortune, vol. 4, no. 10, (1996).
- [14] M. E. J. Newman, "The structure and function of complex networks", SIAM Review, vol. 45, no. 2, (2003), pp. 167-256.
- [15] M. Peltoniemi and E. Vuor, "Business Ecosystem as the New Approach to complex Adaptive Business Environments", Frontiers of E-business Research, (2004), pp. 267-281.
- [16] A. Q. Shen and N. Sundaresan, "eBay: an e-commerce marketplace as a complex network", Proceedings of the fourth ACM international conference on Web search and data mining, (2011), pp. 655-664.
- [17] B. Xiao and I. Benbasat, "Product-related deception in e-commerce: a theoretical perspective", Market Science, vol. 35, no. 1, (2011), pp. 169-196.
- [18] Y. Xiao and M. Xiao, "Study on Competitive Advantage and Construction Strategy of E-Commerce Ecosystem", Proceeding(s) of Business Intelligence and Financial Engineering (BIFE), (2011), pp. 207-210.
- [19] C. C. Zhou and C. Lou, "Principles and Strategies of Optimizing E-Commerce Enterprise Niche", Proceedings of Business Intelligence and Financial Engineering (BIFE), 2011 Fourth International Conference, (2011), pp. 256-259.